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Aggregate Resources Inventory of the Township of Georgina

Regional Municipality of York
Southern Ontario

By Staff of the Maple District Office, Ontario Ministry of Natural Resources, and the Engineering and Terrain Geology Section, Ontario Geological Survey

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Aggregate Resources Inventory of the Township of Georgina Regional Municipality of York

by Staff[1] of the Maple District Office, Ontario Ministry of Natural Resources, and the Engineering and Terrain Geology Section, Ontario Geological Survey

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Abstract

This report includes both an inventory and evaluation of sand and gravel, as well as bedrock resources, in the Township of Georgina. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under the Pits and Quarries Control Act.

The sand and gravel deposits in the township are small and scattered. However, eight of these deposits are suggested for possible resource protection at the primary level. These sources include seven beach deposits and one esker which contain commercially significant amounts of crushable gravel. The Selected Sand and Gravel Resource Areas occupy 900 acres (365 ha), exclusive of licenced properties. An estimated 590 acres (239 ha) are currently available for extraction. Assuming an average deposit thickness for each area, aggregate resources are approximately 18 million tons (16 million tonnes) or 21 percent of the township's total original tonnage.

Sources of secondary significance include two beaches and one windblown deposit. Although the secondary deposits are not the "best" sources, they should be considered as an important part of the township's aggregate supply.

The surficial material in the Township of Georgina is underlain by limestone of the Lindsay Formation. The limestone is acceptable for use in the manufacture of cement but is unsuitable for use as aggregate. For this reason and because of excessive overburden thickness, no areas have been selected for possible resource protection.

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Figure 1. Key Map Showing the Location of the Township of Georgina, Scale 1:1 800 000.

Introduction

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1982, the total tonnage of mineral aggregates extracted was 101 million tons (92 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1983).

Although mineral aggregate deposits are plentiful in Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand and gravel resources as well as a discussion on the potential of bedrock-derived aggregate. The most recent information available has been used to prepare the report. As new information becomes available, revisions may be necessary.

Part I — Inventory Methods

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References) as well as field examination of potential resource areas. Field methods include the examination of natural and man-made exposures of granular material. Most observations are made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites include estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations are also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing, hand augering and geophysical techniques are used to assess subsurface materials. Airphotos at various scales are used to determine the continuity of deposits, especially in areas where information is limited.

Deposits with potential for further extractive development or those where existing data are scarce, are studied in greater detail. Representative layers in these deposits are sampled in 25- to 100-pound (11 to 45 kg) units from existing pit faces or from test pits. The samples are analysed for grain size distribution and in some cases Los Angeles abrasion, absorption, and Magnesium Sulphate soundness tests along with petrographic analyses are performed.

Analyses are performed either in the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, or in the Geoscience Laboratories, Geoservices Section, Ontario Geological Survey. In areas of limited subsurface exposure, test holes are drilled and geophysical surveys using hammer seismic equipment are undertaken. The symbols for and locations of sample and test hole sites along with geophysical traverse lines are noted on Map 1.

In the office, the field data are supplemented by pit information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under the Pits and Quarries Control Act are obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above-named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, are used in some areas to corroborate thickness estimates or to indicate the presence of buried granular material. These records are used in conjunction with other evidence. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 are calculated in the following way. Two successive subtractions are made from the total area. Column 3 accounts for the number of acres unavailable because of the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas that have previously been extracted (e.g. wayside and abandoned pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

Reserve estimates are calculated for deposits of primary significance. Reserve estimates for deposits of secondary and tertiary significance are not calculated in Table 3, however the aggregate potential of these deposits is discussed in the report.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps, and from the interpretation of water well records. The

measured extent of such areas is then multiplied by the estimated quarriable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of 60 feet (18 m) is used for thickness. Volume estimates are then multiplied by the density factor (the estimated weight in tons of a one-foot (0. 3 m) thick section of rock, one acre (0.4 ha) in extent).

Resources of dolostone are calculated using a density factor of 165 pounds per cubic foot (2649 kg per cubic metre) or 3600 tons per acre (8070 tonnes per hectare). Sandstone resources are calculated using a density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) and shale resources are calculated with a factor of 150 pounds per cubic foot (2408 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel deposits are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p.7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

Part II — Data Presentation and Interpretation

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources" shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

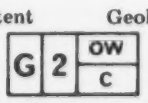
Map 1 is derived from existing surficial geology maps of the area or from airphoto interpretation in areas where surficial mapping is incomplete. The map shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

On the map, all sand and gravel deposits are outlined and shaded. The present level of extractive activity is also indicated. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are identified by a numbered dot on Map 1 and described in Table 2.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for every deposit shown on Map 1. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the deposit contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identifies the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identifies the main quality limitations that may be present in the deposit as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The information from which these symbols are derived has been plotted in grain size distribution graphs. The relative amounts of gravel, sand, and silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol. Geophysics lines are shown on the map by a line symbol.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by dark shading on Map 2.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by light shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Al-

though deposits of secondary significance are not considered to be the "best" resources in the report area, they may contain large quanitities of sand and gravel and should be considered as part of the aggregate supply of the area.

Areas of tertiary significance are outlined on the map by a solid line but have no shading. They are not considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

Selected Sand and Gravel Resource Areas of primary significance are not permanent, single, land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the report area is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6 m), and containing more than 35 percent gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

Aggregate Quality

The limitations of natural aggregates for various uses result from variations in the litholgy of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content (G or S) indicates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (high silt and clay content) may severely limit the potential use of a deposit. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock types determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high quality uses such as concrete and asphalt. Similarly, highly weathered, very porous and friable rock can restrict the quality of an aggregate. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of both the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations.

Analyses of unprocessed samples obtained from test holes, pits or sample sites have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products: Granular Base Course A, B and C; Hot-Laid Asphaltic Sand Nos. 1,2,3,4, and 8; and concrete sand. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

Location and Setting

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on ex-

tractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, powerlines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report, but readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain roughly at the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalites with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, drift thickness and bedrock topography maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources) and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of these areas of thin drift are shown by three levels of shading. The darkest shade indicates where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas consitute potential resource areas because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these zones also represent potential resource ares. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas, the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the report area. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, licenced acreage and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under authority of a permit) are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected drill hole which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics and uses of the bedrock units found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource are usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approch. First, quality and quantity vari ations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas, if present, are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Part III — Assessment of Aggregate Resources in the Township of Georgina

LOCATION AND POPULATION

The Township of Georgina occupies an area of 71,292 acres (28 852) in the northern part of the Regional Municipality of York and includes the former geographic townships of North Gwillimbury and Georgina. The township is shown on portions of the Beaverton (31 D/6), Newmarket (31 D/3), Barrie (31 D/5) and Alliston (31 D/4) map sheets of the National Topographic System, at a scale of 1:50 000.

The main population centres in the township are Keswick, Sutton and Pefferlaw. The population of the township was 19 694 in 1982. Between 1972 and 1982, the population increased by about 30 percent (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974). A further population growth of approximately 3 percent per year is anticipated in the township.

Road access within the township consists of a grid of gravel- topped concession roads. These roads are often spaced irregularly, because of the presence of extensive, low-lying, swampy lands which make construction expensive and difficult. Two major paved roads (King's Highway 48 and Regional Road 8) provide direct access to Metropolitan Toronto.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The Township of Georgina is surrounded in the north and west by Lake Simcoe. This lake was formerly a part of a much bigger water body called Lake Algonquin which existed during the "Great Ice Age" (Chapman and Putnam 1966; Deane 1950). The township itself, is located on flatlands of the Algonquin lake plain (Chapman and Putnam 1966) which is characterized by the occurrence of low, isolated, drumlins. Most of the township's physiographic features were formed during the Late Wisconsinan Substage of the Pleistocene Epoch. The Late Wisconsinan lasted from approximately 23 000 to 10 000 years ago and was marked by the repeated advance and melting back of massive, continental ice sheets.

This repeated advance and melting back of ice sheets left a thick cover of till and varying proportions of glaciofluvial and glaciolacustrine deposits. During the final retreat, all these previously deposited materials were reworked and deposited in various locations as stratified sand, gravel and clays. It is these deposits which are of value as aggregate resources within the township.

A major glaciofluvial event that took place during the final glacial retreat resulted in the development of an esker deposit. The esker trends roughly north-south and is located near the southern border of the township northwest of Brown Hill. The esker cuts across the southern boundary of the township and extends southward into the Town of East Gwillimbury. The esker has been and still is a major source of sand and gravel for the township.

Most of the aggregate deposits are, however, related to the lacustrine phase associated with the final melting back of the ice front. Significant deposition of sand and gravel took place in the form of beaches, bars and spits in the nearshore environment of glacial Lake Algonquin. The water level in this lake fluctuated as shown by the presence of beach deposits at several different elevations. However, at one stage, the water level remained constant for a relatively long period of time. Nearshore deposits formed during this stage are about 5 to 15 feet (1.5 to 5 m) thick, and consist of a fair amount of well sorted, coarse gravel.

Lake Algonquin in this area contained numerous islands formed as a result of drumlins protruding above the water, particularly in and around Sutton. These islands predominantly consist of till with a surface veneer of sand and gravel deposited by lacustrine action. These deposits are likely associated with minor fluctuations of the water level of Lake Algonquin.

The township also contains several very small areas of windblown sand and outwash sand and gravel, most of which are of no major consequence.

EXTRACTIVE ACTIVITY

Numerous sand and gravel pits are scattered across the township. A few of these pits ceased operation in 1975 when the township was designated under The Pits and Quarries Control Act, 1971. Presently, seventeen properties with a total area of 1248.0 acres (505.1 ha) are licenced for extraction under the Act.

A field evaluation of the geology of the licenced sites indicated that roughly 30 percent of the total licenced acreage is likely to be suitable for future aggregate extraction. The remaining 70 percent is unavailable because of one or more of the following reasons:

(i) Depleted areas

(ii) Unproductive areas with thick overburden, poor quality aggregate, etc.

(iii) Various cultural and physical constraints such as high water table, swamps, incompatible adjacent land uses, etc.

An estimated 2.5 million tons (2.3 million tonnes) of gravel and coarse sands suitable for Granular Base Course A road-base material, are available from the licenced properties. The remaining aggregate is of medium to low quality (suitable for Granular Base Course B and C and fill) and approximately 3 to 3.5 million tons (2.7 to 3.2 million tonnes) are available from the licenced properties. The average annual production of aggregate between 1976 and 1981 has been about 400,000 tons (360 000 tonnes) from the licenced properties. If this average annual production trend continues in the future, all the licenced areas will be depleted in a period of 10 to 15 years.

SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 indicates the deposits which contain granular material in the Township of Georgina. The total extent of these deposits is approximately 3650 acres (1480 ha), representing an original tonnage of 87 million tons (79 million tonnes). Many of these potential resource areas will have limited value for reasons

of deposit size, thickness, or quality of the material. Consequently, only the most significant deposits are suggested for possible protection at the primary level.

The sources of primary value are shown on Map 2 and include seven beach deposits and one esker which contain significant amounts of crushable gravel. These sources have a combined area of 900 acres (365 ha), exclusive of licenced properties. Five hundred and ninety acres (239 ha) are currently available for extraction. Total aggregate resources are, therefore, estimated to be 18 million tons (16 million tonnes) or 21 percent of the original tonnage.

Sources of secondary value include two beaches and one windblown deposit. Although the secondary deposits are not the "best" sources, they should be considered part of the township's aggregate supply.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 is part of a Lake Algonquin beach bar deposit which is located about 3 miles (5 km) southwest of Pefferlaw. The deposit occurs as a subdued ridge, rising slightly above the surrounding swampy land.

Area 1 contains one licenced pit (pit 7) and one depleted property which had its licence cancelled in 1982. Field observations made in these pits and data obtained from the Ontario Ministry of Transportation and Communications indicate that the deposit consists of approximately 60 percent crushable stone (Deike 1980). The granular material contains mainly limestone gravel averaging 3 to 4 inches (8 to 10 cm) in diameter. The coarse gravel is acceptable for Granular Base Course A, B and C. The sandy portions of the deposit tend to be dirty in places and would require blending for hot-mix asphalt uses.

Area 1 totals approximately 140 acres (57 ha), exclusive of the licenced property. Cultural constraints and previous extraction reduce the area currently available to 85 acres (34 ha). Assuming an average deposit thickness of 10 feet (3 m), aggregate resources are estimated to be 2 million tons (2 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 is an esker deposit located in the south-central part of the township. A large portion of the deposit is licenced for extraction and there are currently four licenced pits as well as two unlicenced pits in the area (pits 1 to 4, 26 and 27) exposing material ranging from 10 to 60 percent gravel. In two of the properties, extraction has taken place beneath the water table to a depth of 10 to 15 feet (3 to 5 m). Extraction in pit 2 has exposed a gravel core about 100 feet (30 m) wide, which can be excavated to a depth of 50 feet (15 m). Approximately 30 to 35 feet (9 to 11 m) of this material is above the water table.

Area 2 totals 90 acres (36 ha), exclusive of the licenced properties. Cultural constraints and previous extraction reduce the area available to 40 acres (16 ha). Assuming an average deposit thickness of 50 feet (15 m), the total estimated tonnage is 5 million tons (4 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Selected Sand and Gravel Resource Area 3 consists of a series of north-south trending Lake Algonquin beach bar deposits, located south of Sutton in the central part of the township. A prominent topographic feature in the vicinity is a drumlin hill. The beach deposits lie on the western slope of this hill.

There is one licenced pit (pit 13) located in the Area. The pit has a face height of 20 feet (6 m) and exposes bedded sand and gravel layers of varying thickness. The stone content in the pit is approximately 35 percent and consists predominantly of limestone gravel with an average diameter of 3 inches (8 cm).

Area 3 is about 360 acres (146 ha) in extent, exclusive of the licenced property. Of this, 245 acres (99 ha) are currently available for extraction. Assuming an average deposit thickness of 10 feet (3 m), sand and gravel resources are 6 million tons (5 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREAS 4, 5, 6, 7 AND 8

These Selected Sand and Gravel Resource Areas are described as one unit because of their similar geological origin. All of these deposits are small beach bars which occur in scattered locations. In total, there are three licenced pits (pit nos. 10, 12 and 15) and one cancelled property. Face heights range from 10 to 15 feet (3 to 5 m) and contain an overall gravel content of 10 to 25 percent. The aggregate material is comparable to that observed in Selected Sand and Gravel Resource Area 1.

Areas 4, 5, 6, 7 and 8 total 310 acres (125 ha), exclusive of the licenced properties. Approximately 220 acres (89 ha) are potentially available for extraction. Assuming an average deposit thickness of 10 feet (3 m) for each area, aggregate resources are estimated to be 5 million tons (4 million tonnes).

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

Two of the deposits selected at the secondary level are beach bars located near the southern boundary of the township. One of these deposits is adjacent to the esker selected as Sand and Gravel Resource Area 2. Close association with the esker may have resulted in the beach bar having an origin which is partly glaciofluvial and partly glaciolacustrine.

The second beach bar is also a sandy deposit which occurs east of Highway 48, north of Brown Hill. One licenced pit (pit 5) is located in this deposit and extraction in the eastern portion encountered fine to medium sand to a depth of 10 to 20 feet (3 to 6 m). In 1982, the western portion of the pit was excavated and a gravel bar consisting of more than 50 percent gravel was exposed. The exposed portion of the bar in the licenced area has a length of approximately 400 feet (122 m), a width of 150 feet (46 m), and a thickness of 10 to 20 feet (3 to 6 m).

The third deposit of secondary significance is located southwest of Pefferlaw. The material is mainly fine windblown sand underlain by the lacustrine

plain. A licenced pit (pit 8) has a face height of about 10 feet (3 m) and is made up of fine sands.

BEDROCK GEOLOGY

The glacial material in the Township of Georgina is underlain by bedrock of the Lindsay Formation. This formation is Middle to Upper Ordovician in age and consists of relatively flat-lying grey limestone with shaly partings (Liberty 1969). Overburden exceeds 100 feet (30 m) over most of the township. However, there is an area in the northeastern corner where the drift thickness is less than 50 feet (15 m).

The Lindsay Formation bedrock is suitable for use in the production of cement and has been quarried for this purpose at several places in southern Ontario. However, since the rock contains numerous shaly interbeds and partings, it is unsuitable for use as aggregate (Dolar-Mantuani 1975). For this reason and because the rock is covered by an excessive amount of drift, no areas have been selected for resource protection.

SUMMARY

The sand and gravel deposits of the Township of Georgina are the product of glacial activity which occurred during the "Great Ice Age". Although these deposits are small and scattered, there are several which do contain commercially viable quantities of sand and crushable gravel as is shown by the number and distribution of extraction sites. These deposits have been suggested for resource protection and/or development at the primary level and include seven beach bars and one esker. Additional material may be available in the deposits selected at the secondary level.

The surficial material is underlain by limestone of the Lindsay Formation - a unit which has been quarried elsewhere in south-central Ontario for the manufacture of cement. Because the rock is unsuitable for use as aggregate and because of the excessive overburden thickness, no areas have been selected for resource protection.

Enquiries regarding the Aggregate Resources Inventory of the Township of Georgina should be directed to the Ontario Ministry of Natural Resources either at the Maple District Office, Maple, Ontario, L0J 1E0 (Tel. (416) 832-2761) or at the Central Region Office, 10670 Yonge Street, Richmond Hill, Ontario, L4C 3C9 (Tel. (416) 884-9203).

TABLE 1. TOTAL SAND AND GRAVEL RESOURCES, TOWNSHIP OF GEORGINA*.

1 Class No.	2 Deposit Type (see Appendix C)	3 Areal Extent Acres (Hectares)	4 Original Tonnage Millions of Tons (Tonnes)
1	G-E	240 (97)	24 (22)
2	S-IC	30 (12)	1 (1)
	G-LB	1090 (440)	27 (24)
	S-LB	375 (152)	9 (8)
	G-OW	70 (28)	3 (3)
3	G-LB	390 (158)	6 (5)
	S-LB	840 (340)	10 (9)
	S-WD	490 (198)	6 (5)
4	S-LB	120 (49)	1 (1)
		3650 (1480)	87 (79)

N.B. Minor variations in all tables are caused by rounding of data.
* Identified deposit areas within Sibbald Point Provincial Park have been omitted on all tables.

TABLE 2. SAND AND GRAVEL PITS, TOWNSHIP OF GEORGINA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
LICENCED PITS							
1		Gormley Sand & Gravel Ltd.	1	6	34.8 (14.1)	30 (9)	variable, 30-40 max.
2	N2-16	Roger LaRue Enterprises Ltd.	2,3	6	100.0 (40.5)	30 (9)	variable, 40-60 max.
3	N2-64	Floyd Preston	Pt.3	7	37.6 (15.2)	-	30-40
4		James Anderson	Pt.25	7	11.7 (4.7)	15 (5)	30-40
5		G. Chapelle	Pt.1	2	21.0 (8.5)	10-20 (3-6)	10-20
6	B6-53	Gormley Sand & Gravel Ltd.	3	3	204.8 (82.9)	10-15 (3-5)	15-25
7	B6-87	M.N.R.	Pt.13	3	30.0 (12.1)	10 (3)	40-70
8		George Snodden	Pt.17	3	13.7 (5.5)	10 (3)	sand
9		Virginia Aggregate	18	5	30.7 (12.4)	-	sand
10		Twp. of Georgina	Pt.11, 12	5	149.7 (60.6)	10-15 (3-5)	15-25
11		Virginia Aggregate	Pt.9	4	13.6 (5.5)	15 (5)	10-20
12	B6-38	Cedarhurst Quarries & Cr. Ltd.	Pt.7 Pt.7,8	6 5	295.3 (119.5)	10-15 (3-5)	10-20
13		Stephen Johnson	1	5	12.0 (4.9)	20 (6)	30-40
14		J.M. Munro	Pt.19	7	22.0 (8.9)	-	10-20
15		Gerda Friedrichs	Pt.15, 16	9	184.8 (74.8)	10-15 (3-5)	10-20
16		Harold Smith	20	4	70.0 (28.3)	5 (1.5)	10-20
17		William Graves	21	3	16.3 (6.6)	30 (9)	10-20
					1248.0 (505.1)		
UNLICENCED PITS*							
N. Gwillimbury							
18	N2-73	M.N.R.	14	3		-	-
19	N2-7	Gormley Sand & Gravel Ltd.	14	3		-	-
20	N2-25	Unknown	11	3		-	-
21	N2-62	Yorke	13	4		-	-
22	N2-55	Monday	10	4		-	-
23	B6-83	White (Melville)	12	7		-	-

N.B. Minor variations in all tables are caused by rounding of data.

*Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 2. SAND AND GRAVEL PITS, TOWNSHIP OF GEORGINA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
Georgina							
24	N2-63	Parks/Miller Paving	5	7		15 (5)	-
25	N2-101	Twp. of Georgina	5	7		-	-
26	N2-114	Hamilton	5	7		-	-
27	N2-4	Anderson	5	7		20 (6)	10-20

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 3. SELECTED SAND AND GRAVEL RESOURCE AREAS, TOWNSHIP OF GEORGINA.

1 Deposit No.	2 Unlicenced Area Acres (Hectares)	3 Cultural Setbacks Acres (Hectares)	4 Extracted Area Acres (Hectares)	5 Available Area Acres (Hectares)	6 Estimated Deposit Thickness Feet (Metres)	7 Available Aggregate Millions of Tons (Tonnes)
1	140 (57)	25 (10)	30 (12)	85 (34)	10 (3)	2 (2)
2	90 (36)	20 (8)	30 (12)	40 (16)	50 (15)	5 (4)
3	360 146)	100 (40)	15 (6)	245 (99)	10 (3)	6 (5)
4	55 (22)	10 (4)	0 (0)	45 (18)	10 (3)	1 (1)
5	55 (22)	10 (4)	5 (2)	40 (16)	10 (3)	1 (1)
6	70 (28)	15 (6)	5 (2)	50 (20)	10 (3)	1 (1)
7	80 (32)	20 (8)	10 (4)	50 (20)	10 (3)	1 (1)
8	50 (20)	15 (6)	0 (0)	35 (14)	10 (3)	1 (1)
	900 365)	215 (87)	95 (38)	590 (239)		18 (16)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, TOWNSHIP OF GEORGINA

1 DRIFT THICKNESS Feet (Metres)	2 FORMATION	3 ESTIMATED DEPOSIT THICKNESS Feet (Metres)	4 AREAL EXTENT Acres (Hectares)	5 ORIGINAL TONNAGE Millions of Tons (Tonnes)
3-25 (1-8)	Lindsay	60 (18)	2060 (830)	445 (405)
25-50 (8-15)	Lindsay	60 (18)	2950 (1190)	640 (580)
			5000 (2020)	1080 (980)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 5. QUARRIES, TOWNSHIP OF GEORGINA.

1 NO.	2 MTC NO.	3 OWNER/ OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)
			-NONE-			

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 6. SELECTED BEDROCK RESOURCE AREAS, TOWNSHIP OF GEORGINA.

1 **DEPOSIT NO.**	2 **DEPTH OF OVERBURDEN** Feet (Metres)	3 **UNLICENCED AREA** Acres (Hectares)	4 **CULTURAL SETBACKS** Acres (Hectares)	5 **EXTRACTED AREA** Acres (Hectares)	6 **AVAILABLE AREA** Acres (Hectares)	7 **ESTIMATED WORKABLE THICKNESS** Feet (Metres)	8 **AVAILABLE RESOURCES** Millions of Tons (Tonnes)

-NONE-

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 7. SUMMARY OF TEST HOLE DATA, TOWNSHIP OF GEORGINA.

-NONE-

N.B. Minor variations in all tables are caused by rounding of data.

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Appendix A — Suggested Additional Reading

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Appendix B — Glossary

Abrasion resistance: Tests such as the Los Angeles abrasion test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

Absorption capacity: Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

Aggregate: Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

Alkali-aggregate reaction: A chemical reaction between the alkalis of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

Blending: Required in cases of extreme coarseness, fineness, or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

Cambrian: The first period of the Palezoic Era, thought to have covered the time between 570 and 500 million years ago. The Cambrian precedes the Ordovician Period.

Clast: An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of larger rock mass. Synonyms include particle and fragment.

Crushable aggregate: Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

Deleterious lithology: A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

Devonian: A period of the Paleozoic Era thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

Dolostone: A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

Drift: A general term for all unconsolidated rock debris transported from one place and deposited in another, distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

Drumlin: A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were formed beneath an advancing ice sheet, and were shaped by its flow.

Eolian: Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

Fines: A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

Glacial lobe: A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced then melted back numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

Gradation: The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulder	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

Granular base course: Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

Hot-laid (or asphaltic) aggregate: Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2 and 8) used to bind the surface course to the underlying granular base course.

Lithology: The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

Magnesium sulphate soundness test: This test is designed to simulate the action of freezing and thawing on aggregates. Those aggregates which are susceptible will usually break down and give high losses in this test.

Meltwater channel: A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

Ordovician: an early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

Paleozoic Era: One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

Petrographic examination: An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

Pleistocene: An epoch of the recent geological past including the time from approximately 2 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

Possible resource: Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

Shale: A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

Silurian: An early period of the Palezoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

Soundness: The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

Till: Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

Wisconsinan: Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

Appendix C — Geology of Sand and Gravel Deposits

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

Ice-Contact Terraces (ICT): These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous because of extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive because of the variability of the deposits both in terms of quality and grain size distribution.

Kames (K): Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits, producing internal structures characterized by bedding discontinuties. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

Eskers (E): Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

Undifferentiated Ice-Contact Stratified Drift (IC): This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits because of their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

Outwash (OW): Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

Alluvium (AL): Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and they have generally low value because of the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

Glaciolacustrine Beach Deposits (LB): These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

Glaciolacustrine Deltas (LD): These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near- ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

Glaciolacustrine Plains (LP): The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources because of their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

End Moraines (EM): These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

Windblown Deposits (WD): Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consists of fine to coarse sand and are usually well sorted. The probabiltiy of locating crushable aggregate in windblown deposits is very low.

Appendix D — Geology of Bedrock Deposits

BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

Bass Islands Formation (Upper Silurian)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18 m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunnville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate because of high soundness losses.

Bobcaygeon Formation (Middle Ordovician)

Composition: Compact, homogeneous, medium- to thin-bedded, fine- grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

Bois Blanc Formation (Lower-Middle Devonian)

Composition: Brownish grey, medium-crystalline, medium- to thin- bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High cherty content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

Dundee Formation (Middle Devonian)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone. Used at St. Marys as raw material for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

Guil River Formation (Middle Ordovician)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

Lockport and Amabel Formations (Middle Silurian)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive- bedded, fine-to medium-grained dolostone. Thickness: Amabel Formation: maximum observed

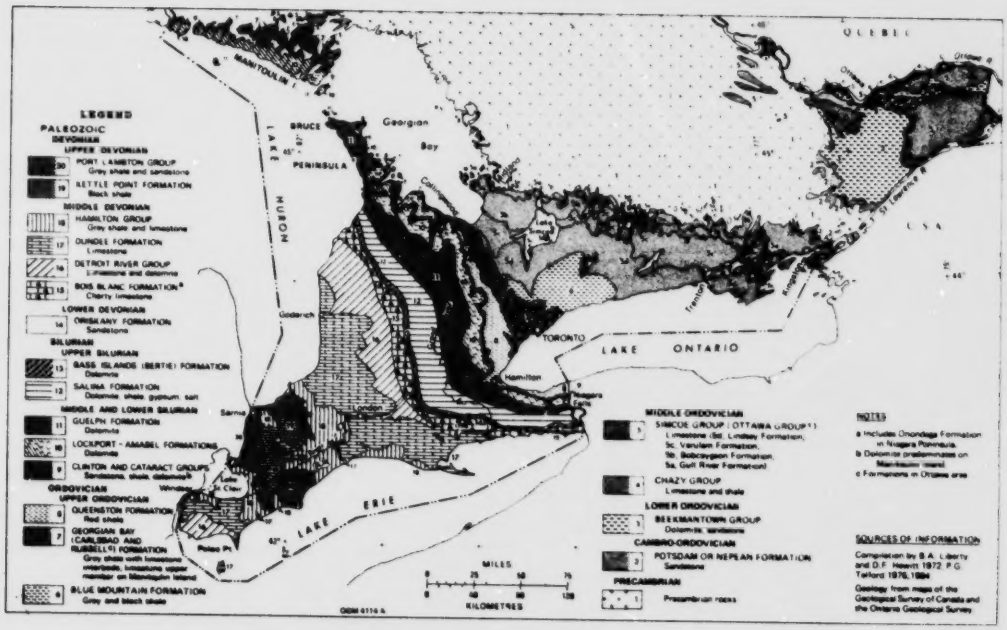


Figure 2. Bedrock Geology of Southern Ontario.

thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

Onondaga Formation (Middle Devonian)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium- grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey- brown, fine-grained, very cherty limestone having estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey-brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High cherty content makes much of the material unsuitable for concrete aggregate.

Ottawa Formation (Middle Ordovician)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of limestone for cement production and agricultural uses.

Oxford Formation (Lower Ordovician)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

Detroit River Group (Middle Devonian)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to micro-crystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces much of Ontario's lime and cement. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for crushed stone.

Grenville Marble (Precambrian)

Composition: Recrystallized fine- to coarse-grained white limestone and dolostone, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

Guelph Formation (Middle Silurian)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. Thickness: 100 to 170 feet (30 to 52 m). Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

Lindsay Formation (Upper Ordovician)

Composition: fine-crystalline, rubbly, nodular-weathering limestone. Collingwood Member: organic-rich interbedded calcareous shales and limestones. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

Verulam Formation (Middle Ordovician)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for use in cement manufacture. The formation is unsuitable for crushed stone because of clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

Georgian Bay Formation (Upper Ordovician) (Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue-grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in the vicinity of Metro Toronto produce brick and structural tile. Lightweight aggregate has been produced at Streetsville by heat expansion of the shale.

Hamilton Group (Middle Devonian)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona Formation is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). The Arkona Formation has a thickness of 14 to 121 feet (4 to 37 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile.

Queenston Formation (Upper Ordovician)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness. 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

Nepean (Potsdam) Formation (Cambro-Ordovician)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

Salina Formation (Upper Silurian)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum. The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

Blue Mountain Formation (Upper Ordovician)

(Formerly known as the Whitby Formation) Composition: Blue-grey, predominantly non-calcareous shale. Uses: Quarried at Bowmanville for use in cement production.

LEGEND

(Continued from right margin)

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in feet (metres)	Tons per acre (Tonnes per hectare)
1	greater than 20 (> 6)	greater than 50,000 (> 112 000)
2	10-20 (3-6)	25,000-50,000 (56 000 - 112 000)
3	5-10 (1.5-3)	12,500 - 25,000 (28 000 - 56 000)
4	less than 5 (< 1.5)	less than 12, 500 (< 28 000)

Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	**LP**	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	**WD**	Windblown Forms

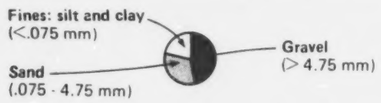
(see Appendix C for descriptions of Geological Types)

Quality Indicator

	If blank, no known limitations present.
C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

TEXTURE SYMBOL

(This symbol is used where sample analysis data are available.)



The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural

LAKE SIMCOE

GEORGINA ISLAND

INDIAN RESERVE 33

Fox Island

Snake Island

Island Grove

Eastbourne

Cook Bay

Brighton Beach

Roches Point

Crescent Beach

Paradise Beach

Willow Beach

Filey Beach

Franklin Beach

Jackson's Point

Briars Park

Sutton (Sutton West P.O.)

Cancelled licenced pit

Cancelled licenced pit

Sports Track

Auto Wreckers

Dugout

Gravel Pit

Gravel Pit

Golf Course

Marina

Convent

BM 820

BLACK CANADIAN NATIONAL

G 3 LB

S 3 LB

G 3 LB

G 2 LB

G 2 LB C

G 2 LB

1/12G

1/18G

1/11G

1/20G

15

28

13

Ministry of Natural Resources
Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

TOWNSHIP OF GEORGINA
REGIONAL MUNICIPALITY OF YORK

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1:50 000

Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS Reference: **31 D/3, 31 D/4**
31 D/5, 31 D/6

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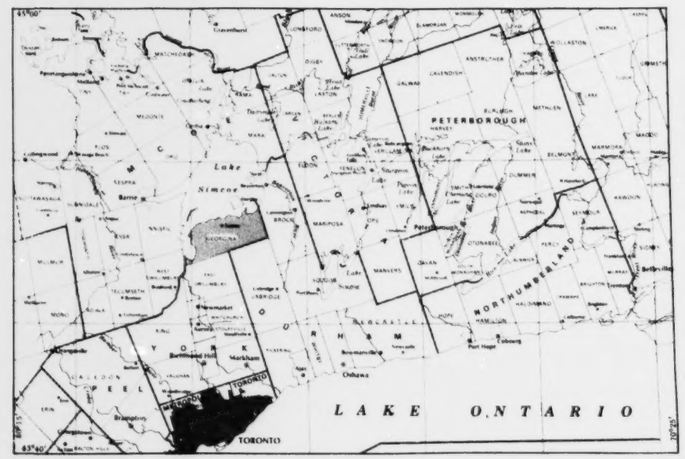

SYMBOLS

(Some symbols may not apply to this map.)

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The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.
Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.
Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.
Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources.
Selected drilled water well data from the Ontario Ministry of the Environment.
Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: R. E. Deane, 1950.

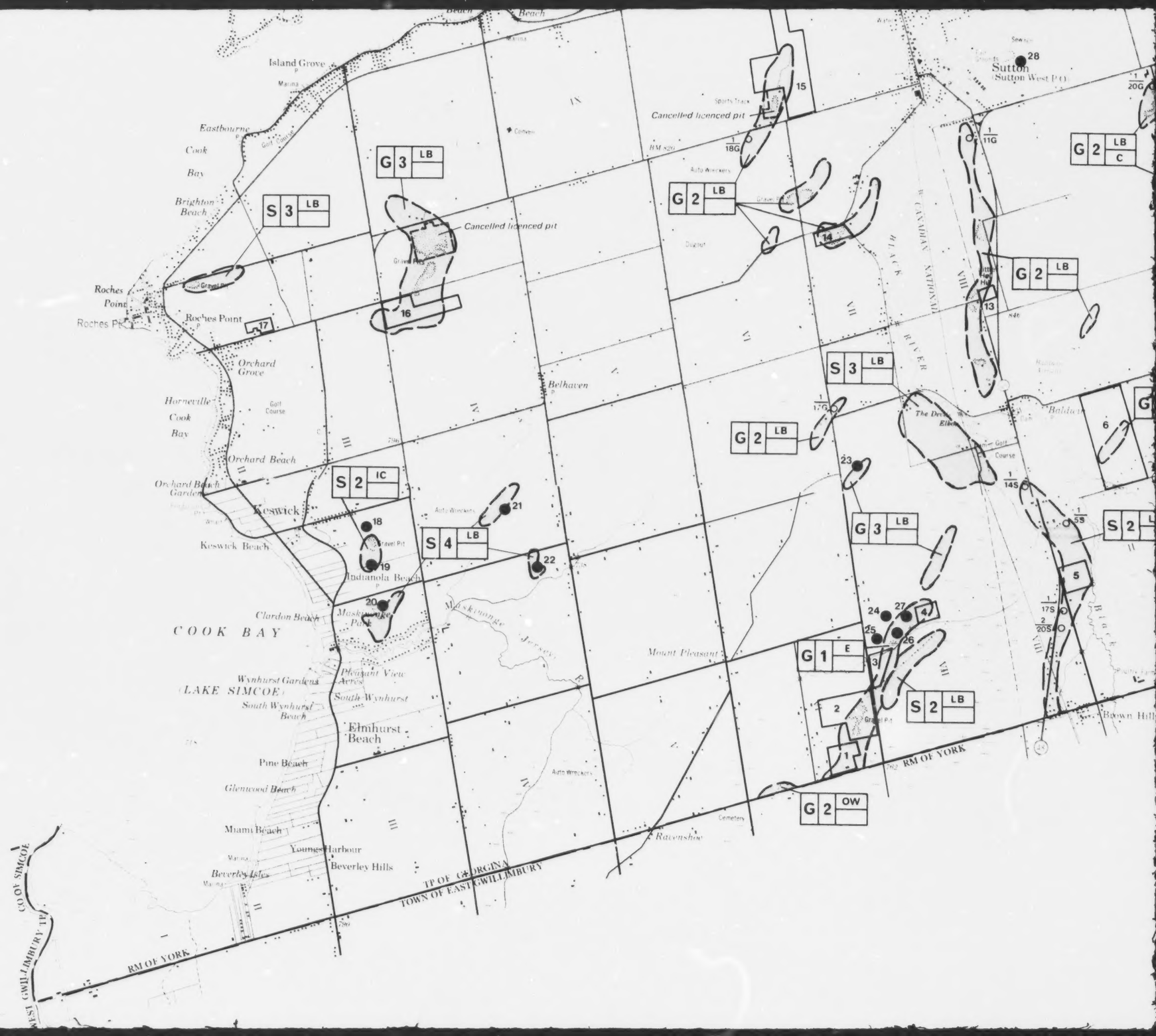
Additional Fieldwork and Compilation by: A. C. Mukherjee, 1982.

Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 116.

This map is published with the permission of V. G. Milne, Director, Ontario Geological Survey.
Issued 1985.

Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.

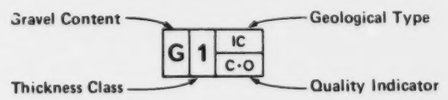


SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary. Shading indicates deposit area.
- Buried geological and aggregate thickness boundary. Shading indicates deposit area.
- Municipal boundary.
- 2 — Licenced property boundary; Property number: see Table 2.
- 3 — Unlicenced sand or gravel pit*; Property number: see Table 2. *Abandoned pit or wayside pit operating on demand under authority of a permit.
- GE-TH-2 — Selected test hole location; Identification number.
- 6/23G — Selected drilled water well location; reported thickness of material (in feet); reported type of material (number only - overburden, T - till, G - gravel, S - sand, C - clay, Bk - bedrock).
- G 1 IC / C-O — Deposit Symbol: see below.
- Texture symbol: see left margin.

DEPOSIT SYMBOL



Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

(Continued at left margin)

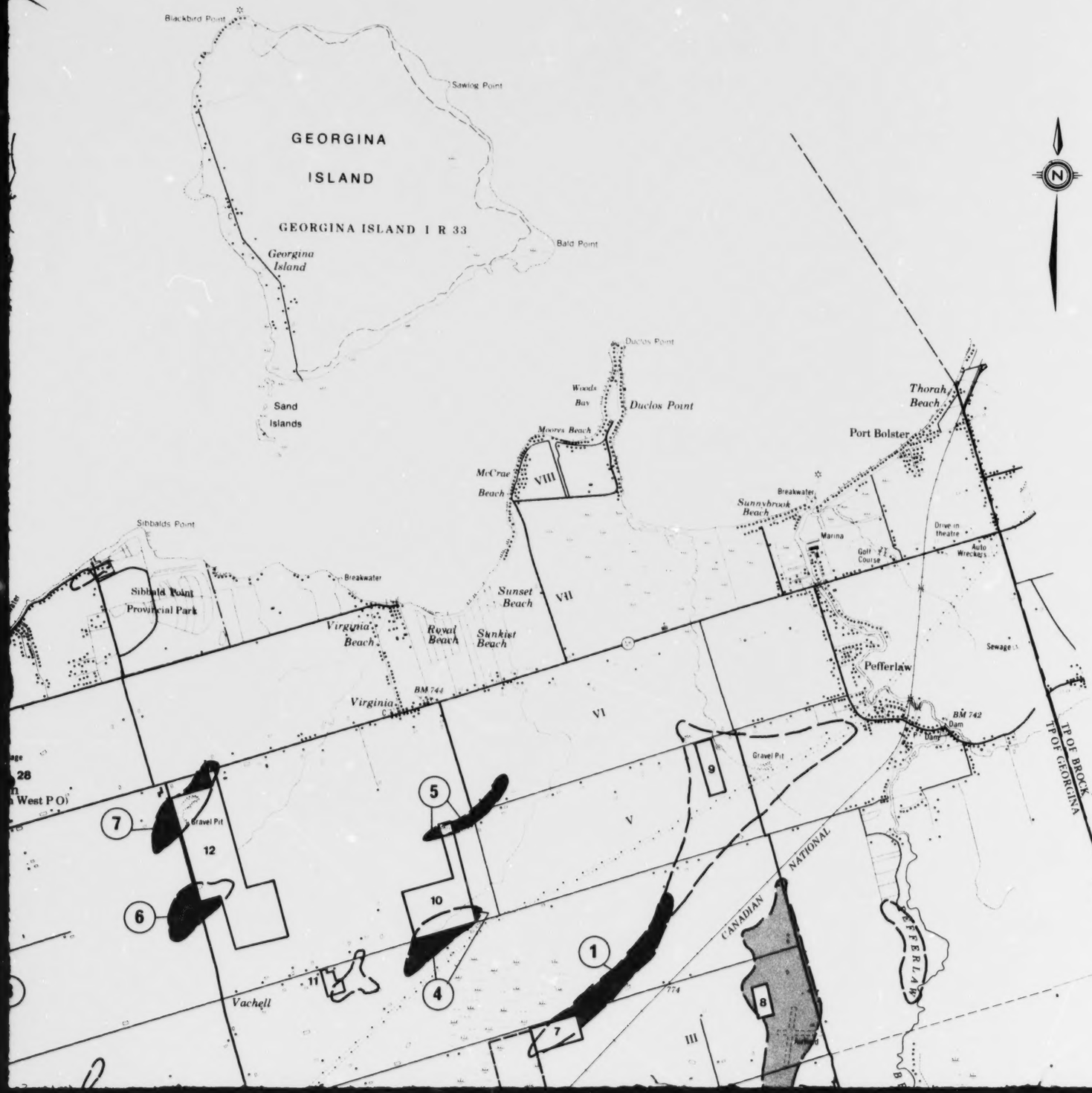
LAKE SIMCOE

GEORGINA ISLAND INDIAN RESERVE 33

GEORGINA ISLAND

GEORGINA ISLAND I R 33

Blackbird Point
Sawlog Point
Bald Point
Georgina Island
Sand Islands
Duclos Point
Woods Bay
Moores Beach
McCrae Beach
VIII
Fox Island
Snake Island
Sibbalds Point
Sibbald Point Provincial Park
Breakwater
Jacksons Point
Marina
Briars Park
Mossington Point
Riley Beach
Jacksons Point
Golf Course
Sunset Beach
VII
Virginia Beach
Rowal Beach
Sunkist Beach
Crescent Beach
Paradise Beach
Willow Beach
Franklin Beach
Water
Sewage
Fair Grounds
28
Sutton
(Sutton West P.O.)
BM 744
Virginia
VI
Island Grove
Marina
Eastbourne
Golf Course
Cook Bay
Brighton Beach
IX
Convent
Sports Track
15
8
Cancelled licenced pit
BM 820
Auto Wreckers
Gravel Pit
Dugout
Cancelled licenced pit
Gravel Pit
16
Roches Point
Roches Point
17
CANADIAN NATIONAL
BLACK
VIII
VII
13
846
Gravel Pit
12
7
6
3
5
10
4
1
11
Vachell
774
7
V



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ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

TOWNSHIP OF GEORGINA
REGIONAL MUNICIPALITY OF YORK

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: **31 D/3, 31 D/4**
31D/5, 31D/6

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SYMBOLS

(Some symbols may not apply to this map.)

Geological and aggregate thickness boundary.

Buried geological and aggregate thickness boundary.

Municipal boundary.

Island Grove
Marina
Eastbourne
Golf Course
Cook
Bay
Brighton
Beach
Roches
Point
Roches Pt
Roches Point
Orchard
Grove
Horneville
Cook
Bay
Golf
Course
Orchard Beach
Orchard Beach
Gardens
Keswick
Wharf
Keswick Beach
Indianola Beach
Clardon Beach
COOK BAY
(LAKE SIMCOE)
Wynhurst Gardens
South Wynhurst
Beach
Pleasant View
Acres
South Wynhurst
Elmhurst
Beach
Pine Beach
Glenwood Beach
Miami Beach
Marina
Beverley Acres
Marina
Youngs Harbour
Beverley Hills
Belhaven
Sports Track
Cancelled licenced pit
Auto Wreckers
Gravel Pit
Cancelled licenced pit
Dugout
Auto Wreckers
Auto Wreckers
Maskinonge
(Jersey)
Mount Pleasant
Auto Wreckers
Cemetery
Ravenshoe
Sewage
Sutton
(Sutton West P O)
CANADIAN NATIONAL
BLACK
RIVER
Baldwin
Airfield
The Devil's
Elbow
Dam
Golf
Course
Baldwin
Egypt
Vachell
Cancelled licenced pit
Zephyr
Cedarbrae
Black
Poultry Farm
Brown Hill
TP OF GEORGINA
TP OF UXBRIDGE
TP OF GEORGINA
TOWN OF EAST GWILLIMBURY
RM OF YORK
RM OF YORK
CO OF SIMCOE
WEST GWILLIMBURY TP
Gravel Pit
Gravel Pit
Gravel Pit

SYMBOLS

(Some symbols may not apply to this map.)

- Geological and aggregate thickness boundary.
- Buried geological and aggregate thickness boundary.
- Municipal boundary.
- Selected sand and gravel resource area; Primary significance; Deposit number: see Table 3.
- Selected sand and gravel resource area; Secondary significance.
- Selected sand and gravel resource area; Tertiary significance.
- 2 — Licenced property boundary; Property number: see Table 2.
- 3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
  *Abandoned pit or wayside pit operating on demand under authority of a permit.

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Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Geology by: R. E. Deane, 1950.

Additional Fieldwork and Compilation by: A. C. Mukherjee, 1982.

Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 116.

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Issued 1985.

GEORGINA

ISLAND

GEORGINA ISLAND I.R. 33

Georgina Island

Sand Islands

LAKE

SIMCOE

GEORGINA ISLAND

INDIAN RESERVE 33

Fox Island

Snake Island

Island Grove

Marina

Eastbourne

Golf Course

Cook Bay

Brighton Beach

Roches Point

Roches Point

Gravel Pit

Crescent Beach

Paradise Beach

Willow Beach

Riley Beach

Franklin Beach

Jackson's Point

Golf Course

Sports Track

Auto Wreckers

Gravel Pits

Dugout

Sibbald Point Provincial Park

Sutton

Sutton West P.O.

Vachell

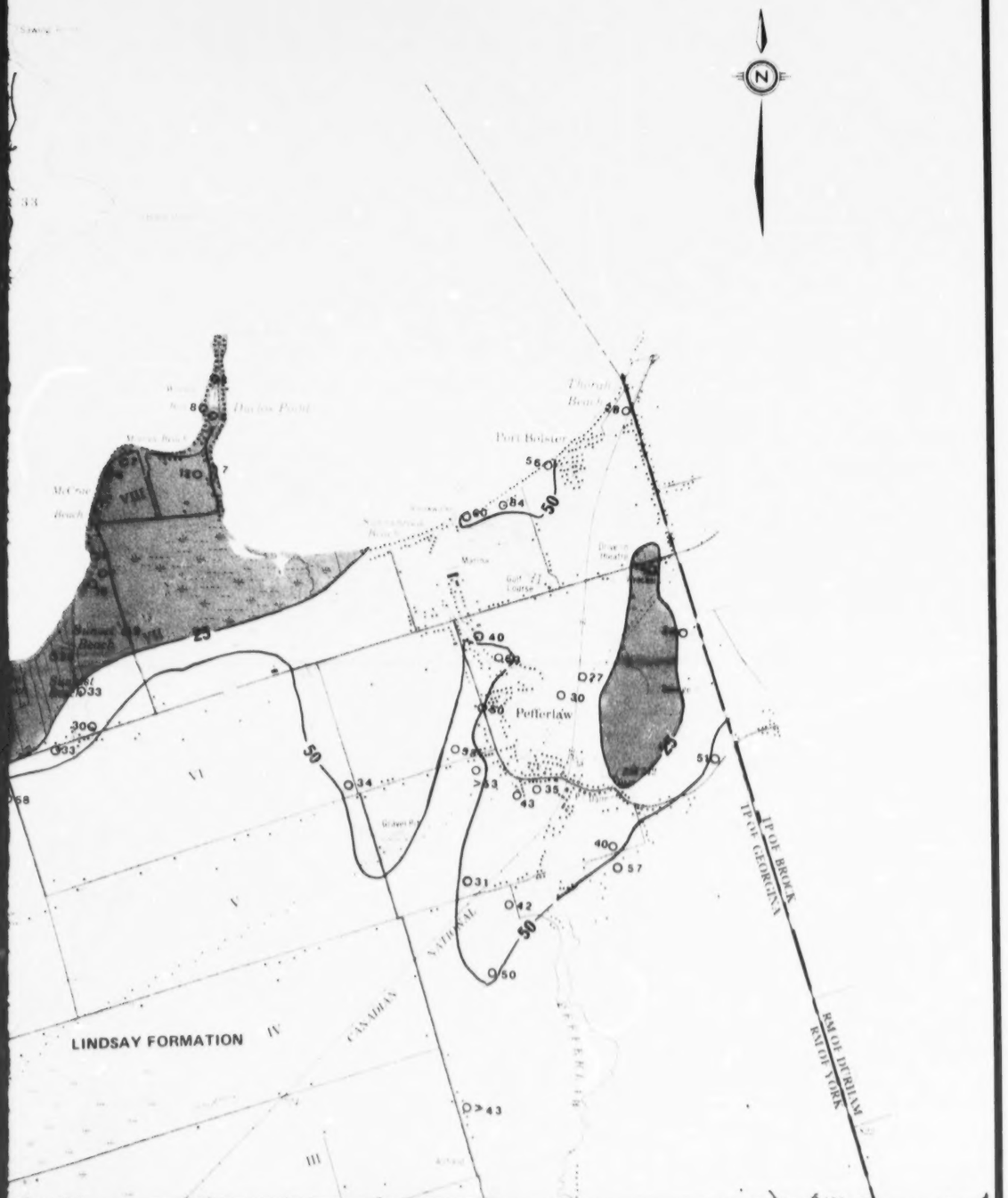
Little Hell Hill

BLACK CANADIAN NATIONAL

LINDSAY FORMATION

>102 >117 >67 >120 116 >112 >114 >116 >87 >120 109 119 129 184 >7 303 45 37 42 33 30 50 60 58 80

IX VIII VII VI V



Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

TOWNSHIP OF GEORGINA
REGIONAL MUNICIPALITY OF YORK

MAP 3
BEDROCK RESOURCES

Scale 1:50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 31 D/3, 31 D/4
31 D/5, 31 D/6

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LEGEND

PALEOZOIC

ORDOVICIAN

SYMBOLS

(Some symbols may not apply to this map.)

Geological formation boundary.

Geological formation member boundary.

Formation thickness boundary (see text).

LINDSAY FORMATION

LINDSAY FORMATION

COOK BAY

LAKE SIMCOE

Island Grove

Eastbourne

Cook Bay

Brighton Beach

Roches Point

Orchard Grove

Hornecliffe

Cook Bay

Orchard Beach

Keswick

Keswick Beach

Mackenzie Park

Clarion Beach

Pleasant View

South Westbrook

Elmhurst Beach

Pine Beach

Glenwood Beach

Miami Beach

Beverley Hills

Sutton

Mount Pleasant

RM OF YORK

TP OF GEORGINA

TOWN OF EAST GWILLIMBURY

CO OF SIMCOE

TP OF WEST GWILLIMBURY

LEGEND

PALEOZOIC

ORDOVICIAN

MIDDLE ORDOVICIAN

LINDSAY FORMATION
Limestone and shale

SYMBOLS

(Some symbols may not apply to this map.)

- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour: 25 foot (8 m) interval.
- Municipal boundary.
- 2 — Selected bedrock resource area. Deposit number: see Table 6.
- Bedrock exposed or near surface; covered by less than 3 feet (1 m) of overburden: see Table 4.
- Bedrock covered by 3 to 25 feet (1 to 8 m) of overburden: see Table 4.
- Bedrock covered by 25 to 50 feet (8 to 15 m) of overburden: see Table 4.
- x — Isolated bedrock outcrop.
- Q2 — Licenced quarry boundary; Property number: see Table 5.
- Q3 — Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.
- O 28 — Selected drilled waterwell location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected drilled water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B.A. Liberty, 1969.

Compilation by: A. C. Mukherjee.

Drafting by: Staff of the Aggregate Assessment Office.

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